Name ______________________ Date ____________ Class ____________

Mass-Mass Relationships in Reactions

Lab 17

Text reference: **Chapter 10, pp. 239–243**

Pre-Lab Discussion

As you have learned, given a balanced chemical equation and the mass of one of the substances in the reaction, the mass of any other substance in the reaction can be calculated. Calculations in which a known mass is used to find an unknown mass in a chemical reaction are called mass-mass calculations.

In this experiment, a double replacement reaction will occur when an aqueous solution of a hydrate of zinc acetate is mixed with an aqueous solution of a hydrate of sodium phosphate tribasic. There are two products of this reaction. One is the insoluble solid (zinc phosphate), which will precipitate out of solution. The other is a soluble salt (sodium acetate), which will remain in solution. The insoluble solid will be separated from the liquid and dried, and its mass determined. The value of the experimentally measured mass of the compound will be compared with the theoretical mass of the compound predicted by a mass-mass calculation.

You may recall that the hydrates of ionic substances have water molecules bound into their crystalline structure. However, they look and feel perfectly dry. When doing mass calculations that involve hydrates, you must be careful to include the mass of the water molecules. For example, the mass of one mole of $CaBr_2 \cdot 6H_2O$ is 308 g/mole:

$$\left.\begin{array}{rl} \text{Ca:} & 1 \times 40\text{ g/mole} = 40\text{ g} \\ \text{2Br:} & 2 \times 80\text{ g/mole} = 160\text{ g} \\ 6H_2O\text{:} & 6 \times 18\text{ g/mole} = 108\text{ g} \end{array}\right\} \quad 308\text{ g/mole } CaBr_2 \cdot 6H_2O$$

This experiment further emphasizes the importance of mass-mass calculations in the chemistry laboratory.

Purpose

To compare the theoretical mass of one of the products of a double replacement reaction with the experimentally determined mass of the same product.

Equipment

- balance
- graduated cylinder, 100-mL
- beakers, 250-mL (2)
- beaker, 100-mL
- stirring rod
- ring stand
- iron ring
- funnel
- safety goggles
- lab apron or coat

Materials

zinc acetate hydrate $[Zn(C_2H_3O_2)_2 \cdot 2H_2O]$
sodium phosphate tribasic hydrate $(Na_3PO_4 \cdot 12H_2O)$
filter paper

Safety

Handle glassware with care to avoid breakage. Always wear safety goggles and a lab apron or coat when working in the lab.

Procedure

1. Using the balance, measure out exactly 2.19 g of zinc acetate hydrate [$Zn(C_2H_3O_2)_2 \cdot 2H_2O$]. Record this mass as (a) in your list of data.

2. Place the $Zn(C_2H_3O_2)_2 \cdot 2H_2O$ in a clean 250-mL beaker and add 50 mL of water. Stir thoroughly to make sure *all crystals are dissolved*. Rinse off the stirring rod.

3. Measure out approximately 2.70 g of sodium phosphate tribasic hydrate ($Na_3PO_4 \cdot 12H_2O$). Place it in a clean 100-mL beaker and add 50 mL of water. Stir until all crystals are dissolved.

4. Pour the $Na_3PO_4 \cdot 12H_2O$ solution into the 250-mL beaker containing the solution of $Zn(C_2H_3O_2)_2 \cdot 2H_2O$. Stir. Record your observations as (d) in your list of data.

write your names in pencil on the filter paper before you get a mass of it.

5. Find the mass of a piece of filter paper. Record this as mass (b). Fold the filter paper and place it in the funnel.

6. Pour the mixture from the 250-mL beaker into the funnel as shown in Figure 17-1. *Pour slowly.* Do not allow the liquid to rise above the edge of the filter paper in the funnel.

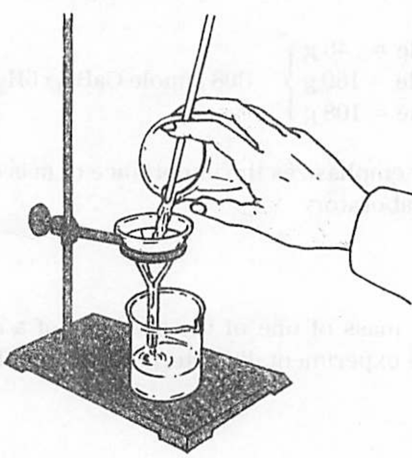

Figure 17-1

7. Rinse the beaker with about 20 mL of water. Pour the rinse water through the filter. Repeat the rinsings and filterings until all the precipitate is out of the beaker.

8. Wash the precipitate by pouring about 10 mL of clean water through the filter.

9. Remove the filter paper and precipitate from the funnel and place overnight in an oven to dry at about 45°C.

10. Find the mass of the *dry* precipitate + filter paper [mass (c) in your list of data].

Name ______________________________

17 Mass-Mass Relationships in Reactions (continued)

Observations and Data

a. mass of $Zn(C_2H_3O_2)_2 \cdot 2H_2O$ __________ g

b. mass of filter paper __________ g

c. mass of filter paper + precipitate __________ g

d. observations

Calculations

1. Write a balanced equation for the double replacement reaction. (The solid formed by the reaction and dried in the oven is zinc phosphate hydrate. Its formula is $Zn_3(PO_4)_2 \cdot 4H_2O$.)

$$\_\_\ Na_3PO_4 \cdot 12H_2O(aq) + \_\_\ Zn(C_2H_3O_2)_2 \cdot 2H_2O(aq) \rightarrow$$

$$\_\_\ Zn_3(PO_4)_2 \cdot 4H_2O(s) + \_\_\ NaC_2H_3O_2(aq) + \_\_\ H_2O(l)$$

2. Using mass-mass calculations, find the theoretical mass of the $Zn_3(PO_4)_2 \cdot 4H_2O$ precipitate that should be produced when 2.19 g of $Zn(C_2H_3O_2)_2 \cdot 2H_2O$ reacts completely. __________ g

3. Find the experimental mass of $Zn_3(PO_4)_2 \cdot 4H_2O$ formed, c − b: __________ g

4. Find your experimental error using the formula: __________ %

$$\text{percent error} = \frac{(\text{observed value} - \text{true value})}{\text{true value}} \times 100$$

Conclusions and Questions

1. What is another name for a double replacement reaction?

2. Give a brief general description of a double replacement reaction. What must one of the products of such a reaction be?

3. Suggest some possible sources of error in this experiment.

4. Define the terms filtrate and precipitate.